LETTERS TO THE EDITOR.

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The Temperature of the Upper Part of Clouds.

AT the recent meeting of the British Association, a report of which appeared in NATURE of October 14 (p. 473), Prof. A. L. Rotch gave an account of the highest balloon ascent in America. It is stated he found the remarkable result that on at least two ascents the temperature increased in a cumulus cloud in passing upwards. It is stated that during the discussion of the paper doubt was expressed as to the reality of the phenomenon. The first thing that strikes one on reading Prof. Rotch's result is that it seems rather curious that this phenomenon had not been recorded in previous ascents. When one considers the conditions, it is only what might be expected. The upper part of the cloud is receiving and dealing with the whole solar radiation falling on its surface, as none of it passes through it. Some of this heat penetrates some distance into the cloud, where it undergoes repeated reflections from the cloud particles. One would thus expect that the cloud particles and the saturated air would absorb some of the heat and have their temperature raised, though probably the greater part of the heat is reflected into space.

There is, however, a point to which I wish to direct attention, and that is to the extreme difficulty of getting anything like correct records of temperature and humidity in the conditions existing at the top of cumulus clouds. On one occasion, while making observations on Pilatus Kulm, the top of the mountain being at the time in dense cloud, but evidently near its upper limit, part of the observations consisted in taking readings of wet- and dry-bulb thermometers, but under the conditions it was found to be very difficult to get trustworthy results. All sorts of abnormal and contradictory readings were at first obtained, even to the wet-bulb reading higher than the dry. A few observations of the surroundings cleared up the difficulties. To begin with, one felt as if in an oven. Radiant heat streamed in from every direction, though no sun was visible, not even the direction of it. An examination of the surfaces of surrounding objects showed them to be in a very abnormal condition, though in the midst of dense cloud many of them were perfectly dry, not the usual dripping condition. The heat reflected from the cloud particles was absorbed by the surrounding objects, and their temperature raised far above the dew point. For instance, a thermometer placed on a large piece of wood showed a temperature of 60° F., while if hung up near it only rose to 48°.

Under the conditions the diffused radiation acted on all surfaces and raised their temperature, but, of course, did not raise them all to the same amount, large bodies, as is well known under these conditions, being much more highly heated than small ones. For instance, ordinary pins driven into a wooden post for hanging the thermometers on got wet, while the post was quite dry. All other freely exposed small objects were wet, and all large ones dry. It was while the thermometers were hung on the post that the wet bulb read higher than the dry, the reason being that the dry was not really dry, but had a film of water over it; and it was colder than the wet bulb, because it was a little smaller, and the wet had also the advantage of a better heat-absorbing surface in its muslin covering. The wet- and dry-bulb temperatures could only be obtained after they had been properly protected from all radiation. In ordinary cloud observations no such protection is required.

As bearing on the question of the heat absorbed by clouds, it may be mentioned that while the observations were being made on Pilatus Kulm the atmosphere was in a constant state of boil, so to speak. Vertical currents were constantly surging up on one side or the other, though there was no wind. These vertical currents were probably due to the disturbing effects of the absorbed heat, and they seem to suggest that this heated upper part of the cloud may explain the formation of those pillar-like clouds sometimes seen rising from sunlit cumulus by the hot part breaking away from the body of the cloud and rising high above it. JOHN AITKEN.

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Lines of Force and Chemical Action of Light.

THE fact that carbon dioxide is dissociated at the low temperature of the surrounding medium, when green organs of plants are exposed to sunlight, has been often considered as somewhat paradoxical. Count Rumford was the first who tried to account for it by suggesting that this process takes place in spaces so small that the temperature produced by the absorption of light may approach the highest temperatures obtainable in our laboratories. More recently I tried to adduce in support of this ingenious interpretation some considerations, derived from the experimental study of the actual conditions of this photo-chemical process.[1] Still more wonderful is the possibility of its going on, though very slowly, in diffused sunlight. But perhaps in the whole range of photo-chemical phenomena there is no fact more wonderful than the possibility of obtaining photographs of the remotest star or nebula.

All these photo-chemical riddles seem to me to find their full explanation in Sir Joseph Thomson's theory,[2] so eloquently expressed in his recent presidential address to the British Association at Winnipeg.[3]

If "a wave of light may be regarded as made of groups of lines of electric force," if "in the wave front there cannot be uniformity," and "it must be more analogous to bright specks on a dark ground than to a uniformly illuminated surface," then it becomes evident that the chemical effect of light on a single molecule cannot fall off in the same ratio as the dispersion of light in space. A single molecule lying in the path of a line of force may be, with regard to the distant sun or star, in the same condition as another molecule in the nearest proximity of these centres of energy. It will be only the number of molecules attacked that will be reduced with the increasing divergence of the lines of force, and this result can be compensated by prolonging the exposition. It seems to me that Sir Joseph Thomson's theory furnishes for the first time a real explanation for the fact that a ray of light is not deprived of its photo-chemical efficiency, no matter how great the distance between the source of energy and the molecule acted upon.[4] These considerations may give us perhaps a deeper insight into the part played by radiant energy in the chemistry of the universe than we possess until now.

A full discussion of the problem would require, of course, something more than the very modest scientific equipment of a botanist, and I should be very grateful if a more competent reader of NATURE would find it worth while to decide the question whether the conclusions here deduced are really consistent with Sir Joseph Thomson's theory.

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The Position of the Radio-active Elements in the Periodic Table.

MANY arrangements have been suggested, which include the radio-active elements in the periodic table. So far as I am aware, these have all attempted to confine each space in the table to a single element. This restriction has led to unlikely assumptions, on account of the large number of these elements, and the limited number of spaces vacant preceding uranium.

From analogy with organic compounds it seems possible that different internal structures of the atoms of the heavier elements may exist, resulting in elements of the same weight with perhaps very different properties. Similarly,

[1] In my Croonian lecture on "The Cosmical Function of the Green Plant" (Proc. Roy. Soc., vol. lxxii., p. 454).

[2] "Electricity and Matter." (1903.)

[3] NATURE, August 26, p. 253.

[4] For instance, it seems to me that the following lines, though referring to photo-electric, may be as well applied to photo-chemical phenomena: ". . . thus any effect which can be produced by a unit by itself will, when the source of light is removed to a greater distance, take place, less frequently it is true; but when it takes place it will be of the same character as when the intensity of light was stronger." Sir Joseph Thomson, "On the Ionisation of Gases by Ultra-violet Light, &c." (Proceedings of the Cambridge Philosophical Society, vol. xiv., part iv., p. 421).

elements with very nearly the same weight might possess very similar properties. This would allow the truth of the following table, in which only three assumptions are made.

(1) It is possible that two elements of nearly the same atomic weight may occupy the same place in the table.

(2) The emission of an α-particle is accompanied by the production of an element which occupies the adjacent space of lower atomic weight.

(3) The emission of a β-particle, or a rayless change, may or may not be accompanied by a remove to a space of lower atomic weight.

In the table the elements which emit α-particles are printed in thick type, the other radio-active elements in italics.

depends, of course, on the *specific* physical and chemical properties they possess. These are often none too well defined. The mechanism of a rayless change, or one accompanied by the emission of a β-particle, may be compared with a change of frequent occurrence with organic compounds, the formation of one desmotropic substance from another under the influence of heat.

It must be remembered that should the conclusions be correct which are drawn from the recent work of Ramsay and Gray on the boiling point and critical constants of radium emanation, and should the atomic weight of 176 be confirmed, not only are the above arguments invalidated, but the whole theory of disintegration put forward by Rutherford and Soddy will require modification.

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								H 1
He 4	Li 7	Be 9	B 11	C 12	N 14	O 16	Fl 19	
Ne 20	Na 23	Mg 24	Al 27	Si 28	P 31	S 32	Cl 35·5	
Ar 40	*K* 39	Ca 40	Sc 44	Ti 48	V 51	Cr 52	Mn 55	Fe Co Ni 56 59 59
	Cu 64	Zn 65	Ga 70	Ge 72	As 75	Se 79	Br 80	
Kr 83	*Rb* 85·5	Sr 88	Y 89	Zr 90	Cb 93·5	Mo 96	Np? 100?	Ru Rh Pd 102 103 107
	Ag 108	Cd 112	Am 115	Sn 119	Sb 120	Te 127·5	I 127	
X 131	Cs 133	Ba 137	La 139	Ce, &c. 140–178	Ta 181	W 184		Os Ir Pt 191 193 195
	Au 197	Hg 200	Tl 204	Pb 207	Bi 208 ←**RaF**←*E₂*←*E₁*←*D*	?←*Act C* ←**Th C** ←**Ra C**←*RaB*	←**Act B**←*A* ←**Th B**←*A* ←**RaA**	
←**Act Em** ←**Th Em** ←**Ra Em**	←**ActX′** ← ←**ThX** ← ←	**Radio-Act** ← **Radio-Th** ← **Ra** ← 226·5	*Act* *Mesoth.2*←*I*← **Ionium** ←	Th 232·5 *UrX*	←**Radio-Ur?**	**Ur** 238·5		

In considering this table, if we assume that Rutherford and Soddy's theory, that the loss of an α-particle is accompanied by a corresponding decrease of 4 in the atomic weight, is correct, it seems certainly necessary to confine radium and radio-thorium to the same space in the table. They are both members of the barium series. The atomic weight of radium is 226·5, while that of radio-thorium must be $(232{\cdot}5-4)=228{\cdot}5$. Similarly the thorium and radium emanations resemble each other so closely that it is legitimate to suppose that they occupy the same space. They condense at almost the same temperature, while their rates of diffusion into other gases are very nearly the same. If one case is admitted, the whole is rendered probable. The evidence with the actinium series is not so positive, but the present arrangement satisfies the known facts.

It may be pointed out that there are three α-emitting elements between radium emanation and lead, and only three spaces in the table, and two α-emitting elements between thorium emanation and bismuth, with two spaces corresponding; lead and bismuth were suggested by Rutherford and Boltwood as the respective end-products of these series. Again, it may be emphasised that the anomalous existence of the group of rare earth metals, giving a difference of more than 40 in the atomic weight of the elements which precede and follow them, explains the change of the difference between two elements of a vertical series from about 46 to nearly twice that figure, so that no element of the argon series is to be expected between xenon and one with a weight about 220. *Except in the two spaces in the vertical series below manganese*, and possibly in the rare earth series, *there is no vacant space in the periodic table between hydrogen and uranium.* In this connection it is interesting to recall the suggestion of R. W. Wood (Astrophys. Journ., 1908, vol. xxviii., p. 75), that the green line in the spectrum of the sun's corona is the fluorescent line of some common element, and that the supposed element "coronium" of weight less than hydrogen does not exist.

It is possible that other β-emitting or rayless elements may be discovered. How far these are really *elements*

Radio-activity and the Rocks.

IN the course of some observations which I have recently made with regard to the pleochroic halos sometimes seen round inclusions in various rock-forming minerals, certain points have suggested themselves as possibly of considerable significance. It may be premised that Prof. Joly's suggestion that the halos are due to the α rays emitted by radium appears fully borne out by their remarkable constancy in size and by the fact that they are invariably connected with minerals independently known to be strongly radio-active, that is, comparatively speaking. The only qualification that need be made respecting this view is with regard to the possibility of radio-active substances other than radium producing the observed effects.

So far as my experience goes, the following minerals are capable of producing halos when enclosed in suitable substances like biotite, cordierite, hornblende, tourmaline, &c., zircon, orthite (allanite), epidote, sphene, and apatite. All these are silicates, except apatite, which is a phosphate. The last three are lime compounds, which does not, however, seem to be of any particular import. Zircon contains zirconium, orthite cerium and its allies, and sphene titanium, and it may be noted that orthite always contains thorium in some quantity, while both zircon and sphene may be expected, from a mineralogical point of view, to contain that element as an impurity. Epidote, being isomorphous with orthite, and frequently intergrown with it in rocks, the presence of some traces of thorium may also be generally presumed. As regards apatite, it is obviously significant that the other two phosphates which occasionally occur as rock-formers, namely, monazite and xenotime, always contain thorium in considerable amount; indeed, monazite owes its commercial value to the constant presence of that element. It would appear, therefore, as if the radio-activity of all the minerals cited might, unless other considerations are opposed to the idea, be fairly attributed to the presence of thorium.

There is, however, another feature of these minerals which may be of significance. It will be noticed that one or other of them contains all the elements grouped under